Materiel Test Procedure 3-2-066*
Aberdeen Proving Ground

5 October 1966

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

RECOILLESS WEAPONS

1. OBJECTIVE

The objective of this test procedure is to provide a guide for the testing of recoilless weapons and their mounts.

2. BACKGROUND

Recoilless weapons provide lightweight portable armament for infantry and antitank use. These weapons are breech operated, single or multiple loading, and may be fired from the shoulder, from bipods, or from mobile mounts, depending on the size of weapon and the tactical employment.

The basic principle in the operation of recoilless weapons involves the release of a portion of the propellent gases in a direction opposing the travel of the projectile. These gases are controlled and directed so as to maintain equilibrium between the opposing forces, thus reducing the tendency of the weapon to "kick" or recoil.

3. REQUIRED EQUIPMENT

a. Chamber pressure-time, velocity and recoil momentum recording devices.
b. Photographic instrumentation
c. Environmental facilities
d. Chronographs
e. Instrumentation for recording stress and strain
f. Instrumentation for recording blast pressures and defining near danger area.
g. Instrumentation for recording continuous weapon temperature histories during various firings.

4. REFERENCES

A. MTP 3-2-502, Safety Evaluation - Artillery Weapons, Mortars, and Recoilless Rifles.
B. MTP 3-2-509, Guns and Howitzers
C. MTP 3-2-510, Artillery Carriages and Mounts
D. MTP 3-2-806, Materiel Testing - Nondestructive Examination
E. MTP 3-2-808, Strain Measurements - Instrumental
F. MTP 4-2-822, Airblast Pressure Measurement - Electronic
G. MTP 3-2-811, Noise and Blast Measurements
H. MTP 3-2-601, Vertical Target Accuracy, Dispersion, and Time-of-Flight Tests

*Supersedes OPM 30-30

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I. MTP 3-2-513, Hand and Shoulder Weapons
J. MTP 2-2-511, Road Tests of Mobile Weapons
K. AR 705-15, Operation of Materiel Under Extreme Conditions of Environment, 14 October 1963, with latest changes.
L. AMCP 706-252, Gun Tubes, February 1964
M. Environmental Simulation Requirements of Development and Proof Services, Aberdeen Proving Ground, Md., Report No. DPS-1493, October 1964.

5. SCOPE

5.1 SUMMARY

The procedures outlined in this and in referenced pamphlets show the sequency of operations and the methods to be employed for the testing of recoilless weapons. Specific test titles are listed below with their respective objectives.

a. Operational Tests - The objective of this test is to determine if the weapon is in operating condition, and if any part of the operator will be exposed to the exhaust gases of the breech. The firing circuit interlocks for the loaders are checked in this test.

b. Proof Firing - The objective of this test is to determine the performance of the weapon when it is fired.

c. Blast and Noise Tests - The objective of this test is to determine the effect of blast and noise of the weapon upon personnel and structures.

d. Flash Test - The objective of this test is to determine the size, shape and druation of the breech and muzzle flash.

e. Cook-Off Test and Rates of Fire - The objective of this test is to determine if a round may be discharged by the absorption of heat from the chamber and tube of the weapon and to determine the maximum rate of fire.

f. Dispersion and Accuracy Tests - The objective of this test is to determine the accuracy and dispersion of fire of the weapon and of the weapon on its mounts.

5.2 LIMITATIONS

This test is limited to those tests which determine the engineering characteristics of the weapon. It does not include such tests as service and environmental tests which are described in other MTP's and may run as required by the Qualitative Materiel Requirement (QMR), Small Development Requirement (SDR), Technical Requirement (TR) or other applicable documents.

6. PROCEDURE

6.1 PREPARATION FOR TEST

All items should be thoroughly examined and inspected. Most of the before-fire procedures discussed in MTP's 3-2-509, and 3-2-510, are applicalbe to recoilless weapons and their components.

Examine the weapon and mount for metallurgical flaws by means of a magnetic particle inspection. Nonmagnetic metals may be inspected by use of penetrating, fluorescent oils. (See MTP 3-2-860).

6,2 TEST CONDUCT

6.2.1 Operational Tests

a. Mount the weapon in its firing position.
b. Operate the breech and loading mechanism.

NOTE: Ensure that any safety devices which prevent the weapon from firing before the loader has moved to a safe position are properly functioning, and that no part of the operator is exposed to the exterior gases of the breech during this period of operation.

c. Mount the sighting device on the weapon.
d. Align the sighting device with the bore.
e. Level the sighting device.
f. Move the trunnions so that the elevation and traversing axis are slightly inclined from the vertical and horizontal.
g. Relevel the sight.
h. Repeat the process ten times or until the sight can no longer be leveled.
i. Record the inclination and cant at which the sight can no longer be leveled.
j. With the weapon mounted and the sight aligned and leveled, check the ability to track moving targets at ranges of 100, 1000, 3000, and 5000 meters at target speeds at each range of 10 to 50 mph in steps of 10 mph. The targets are to move parallel to the weapons baseline.
k. Record the target speed and range and the tracking accuracy of the weapon.

6.2.2 Proof Firing

a. Establish reference (trammel) points and guide line for all members likely to be deformed or displaced during the firing phases or which may be subjected to excessive wear during the test.
b. Star gage the bore of the weapon. Examine the interior of the tube with a bore scope.
c. Record the individual dimensions and areas of the vents.
d. Measure the breech space and protrusion of the firing pin.
e. Measure the force required to operate the firing mechanism.
f. Scribe the junction of the tube and chamber so that any rotation of the tube can be observed.
g. Check the location of bore sight lines on the muzzle for orientation with the axis of the tube
h. Photograph the venturi and breech block or other components likely to be affected by the expelled gases.

i. Determine weight and weight reactions of the weapon and carriage by the method described in MTP 3-2-510.

j. Mount the weapon in a ballistic pendulum.

k. Load propellant of suitable granulation.

l. Fire rounds from the gun in the sequences indicated:

No. of Rounds	Percent of Rated Maximum Pressure	Data Measured		
		Velocity	Pressure	Recoil Momentum
1	75	X	X	X
1	100	X	X	X
3	115	.....	X	.....
3	*	X	X	X

* Service charge rounds - i.e., rounds loaded for service velocity with resultant pressure less than the rated maximum pressure (rmp) at 70° F.

m. Record the horizontal deflection of the weapon and the period of the pendulum.

n. Examine the finished surfaces of moving parts for evidence of scoring or excessive wear.

o. Star gage and borescope the tube again.

p. Repeat all before-fire measurements.

6.2.3 Blast and Noise Tests

a. Mount the weapon on its tactical mount.

b. Place pencil and pancake gages, as described in MTP 4-2-822, in concentric circular patterns around the firing point.

c. Microphones or paper blast meters may be used for back-up instrumentation. If paper blast meters are used follow procedures contained in MTP 4-2-823.

6.2.4 Flash Tests

a. Mount the weapon as in 6.2.3, (a).

b. Mount a high-speed motion picture camera to the side of the firing point with two reference scales located to facilitate photogrammectric data reduction

c. The test is to be conducted during the hours of darkness.

d. Start the cameras and fire the weapon.

e. Preserve the camera film.

6.2.5 Cook-Off and Rates of Fire Test

a. Mount the weapon as in 6.2.3 (a).

b. The rounds to be fired will have inert projectiles of the maximum permissible design weight. The propellent weight should be that which produces rated maximum pressure (rmp) at 70° F. At least 100 rounds should be so loaded.

c. Condition the rounds in a hot chamber to 145° F.

d. The test is to be conducted with wind velocities of less than 5 mph.

e. Instrument the gun tube and chamber with thermocouples and record the ambient temperature.

f. Fire the rounds as rapidly as possible or until the limiting temperature for the weapon is reached.

g. Chamber a "cook-off" round and note the time that it takes for a "cook-off" to occur.

h. If no cook-off occurs the test is terminated.

i. If a cook-off is obtained the test is repeated at a lower rate of fire until a temperature 30°- 50° lower than in the previous test is obtained.

j. Observe whether any damage occurs to the bore, breech, trigger mechanism, or vents.

k. Record the rates of fire, temperatures, and other pertinent data.

6.2.6 Dispersion and Accuracy Tests

The dispersion and accuracy test is to be conducted in accordance with MTP 3-2-601.

6.3 TEST DATA

6.3.1 Operational Tests

Record maximum inclination and cant at which the sight can be leveled. (Degrees). Record any obvious operational shortcomings of the weapon. Record the range of the targets in meters and the target speed in mph. Record the tracking rate of the weapon in degrees/sec.

6.3.2 Proof Firing

Record the horizontal deflection of the weapon in inches, the period of the pendulum in sec. and the rotation if any, of the tube in mils. Record any wear that occurred on the weapon during firing.

6.3.3 Blast and Noise Tests

Record data as specified in MTP's 3-2-811 and 4-2-822.

6.3.4 Flash Test

Record the camera locations and the film speed in in/sec.

6.3.5 Cook Off and Rate of Fire Test

Record the number of rounds used in each test. Record the rate of fire

in rounds per min. Record the weapon temperature in degrees Fahernheit. Record the cook-off time in seconds. Record any damage that occured.

6.3.6 Dispersion and Accuracy Test

Record data in accordance with MTP 3-2-601.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Operational Tests

Prepare table of target speed and distance versus tracking rates.

6.4.2 Proof Firing

When firing recoilless weapons from the ballistic pendulum, horizontal deflection of the assembly is recorded in inches and may be assigned a positive or negative sign to correspond with the direction of the initial movement. A positive sign designates movement of the pendulum in the direction opposite that taken by the projectile; a negative sign indicates movement in the same direction as the projectile.

The measured horizontal deflection of the system (weapon and cradle) is converted to momentum units by means of:

(1) $$M = \frac{Wd}{12\sqrt{gL}}$$

M = Momentum (pound-seconds)
w = Weight of suspended system (pounds)
g = 32.2 feet/per sec^2
d = Horizontal deflection (inches)
L = Effective length of the pendulum suspension (feet)

The design of the pendulum should ensure that the deflection does not exceed one-twentieth of the effective length of suspension. The effective pendulum length is given by:

(2) $$L = g\left[\frac{T}{2\pi}\right]2$$

Where T is the observed period of oscillation (seconds), taken as the average time for 10 successive oscillations. Combining equation (1) and (2) gives an expression for the conversion factor,

$$\frac{M}{d}$$

(3) $$\frac{M}{d} = \frac{w\,\pi}{6gT} = \frac{0.01626w}{T}$$ pounds-seconds per inch

Tabulate the data as indicated in paragraph 6.2.2.

6.4.3 Blast and Noise Tests

Reduce the data in accordance with MTP/s 4-2-822 and 3-2-811.

6.4.4 Flash Test

From the camera films make plots of muzzle and breech flash height and length versus time.

6.4.5 Cook-Off Test

Tabulate the data taken in paragraph 6.3.5 as rate of fire versus cook-off time and temperature.

6.4.6 Accuracy and Dispersion Test

Reduce the data in accordance with MTP 3-2-601.